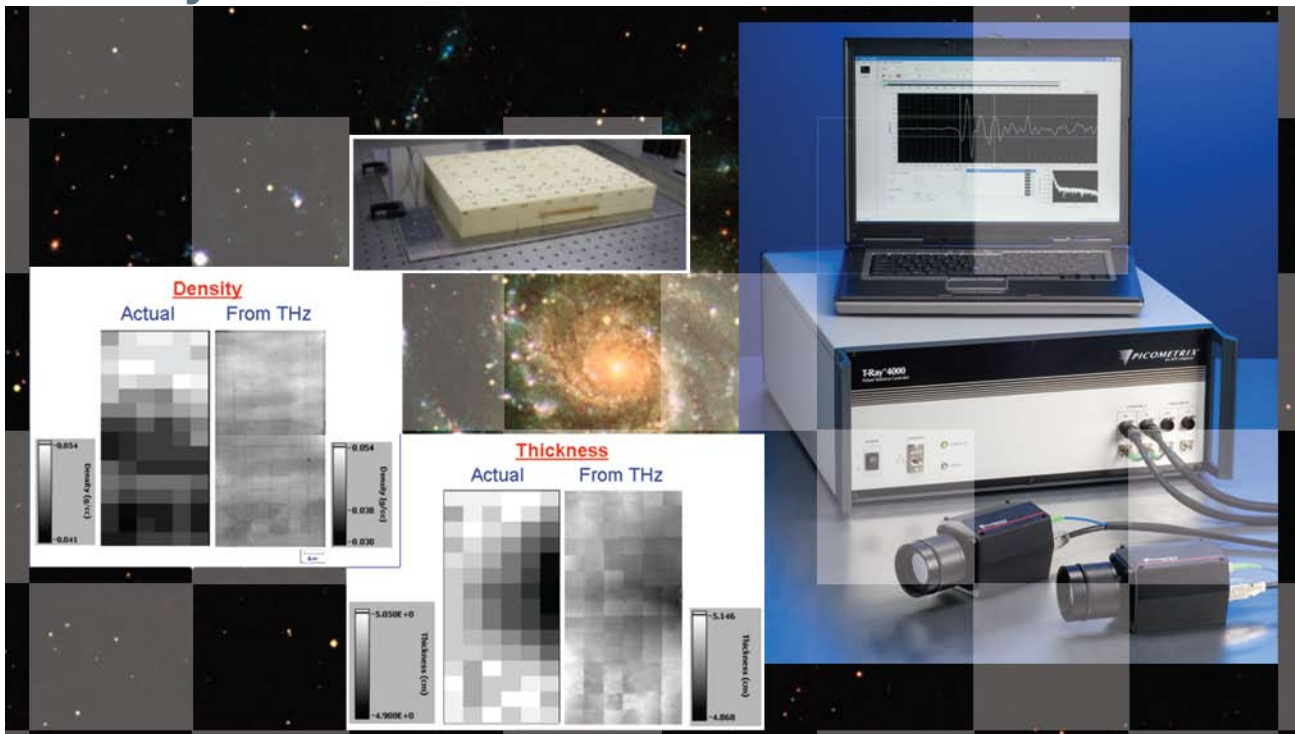




technology opportunity

Method for Measuring Thickness and Density Variations in Dielectric Materials



After a chunk of foam insulation broke off of the external fuel tank during launch and damaged the Columbia space shuttle, causing it to burn up on reentry, finding a non-destructive method for evaluating spray-on foam insulation (SOFI) became a high priority for NASA. Terahertz (THz) imaging developed by Picometrix, Inc. was evaluated for detection of discrete flaws such as voids in the foams. Additionally, researchers at NASA Glenn Research Center designed a non-contact precision measurement method for determining thickness and density variations in dielectric materials, using terahertz energy.

Benefits

- **Safe.** The method uses non-ionizing radiation and will not cause damage as X-rays can.
- **Precise.** The simultaneous determination of thickness and microstructural variation obviates the need to make assumptions about the velocity of the radiation in the material to determine thickness and density.
- **Easy to use.** Measurements are made non-destructively, without contact.
- **Portable.** THz laser systems are compact, so inspection tools are mobile and can be used in the field or laboratory.
- **No coupling needed.** Other methods require the material to be in contact with water or aqueous gel, which is not always feasible or possible, depending on the material and location.
- **Wide applicability.** Many types of materials can be measured using this method.

Applications

Organic foams:

- Foam and foam cores used for construction projects, such as rigid foam insulation for cladding buildings
- Foam cores for advanced composites used in space and satellite structures, airplane structures and engines, racing cars, yachts, other sports equipment, and wind turbine blades

Paper and other mill products:

- Process control and post-production inspection of paper, paperboard, and tissue
- Paper, wood, and other mill products:

Dense ceramics:

- Thermal barrier coatings for jet engine and energy gas turbines, and diesel and automotive engines
- Ceramic matrix composites (CMCs), such as for liners, hot gas heat exchangers, and missiles
- Solid oxide fuel cells (SOFCs)
- Ceramic armor
- Ceramic radomes
- Ceramic dielectric substrates for microelectronics and microwave dielectric resonators

Porous ceramics:

- Thermal protection systems (TPSs) such as alumina-enhanced thermal barriers
- Advanced insulation for cryogenics

Technology Details

The GRC density and thickness methodology can be used in theory with any terahertz imaging equipment as long as the raw data is in the proper format. A software executable for processing waveform- and image-based nondestructive evaluation (NDE) scan data such as that from ultrasonic, terahertz, and microwave methods is available on the GRC software repository at <https://technology.grc.nasa.gov/software>. The software package includes example data sets so that users can learn the software operation before obtaining their own test data.

How It Works

This THz (electromagnetic) inspection imaging method uses a non-ionizing beam of energy to simultaneously characterize microstructural and thickness variation in dielectric (insulating) materials. Needing access to only one side of the material, the method sends a beam through the material and detects echo pulses off of the material surface and the backing metallic (or otherwise electrically conducting) substrate. Density and thickness are determined by mathematical manipulation of the arrival times of the pulses.

Why It Is Better

The method results in a more precise determination of both density and thickness because the calculations are based on data rather than on assumptions, such as the density remaining constant across the surface. In fact, no prior knowledge of sample thickness is required to obtain accurate data. Previous methods do not take into account microstructural variations that can occur from, for instance, improper processing or spraying of insulation material. The measurements are collected without having to soak the material with water, something that is not always feasible, depending on the material, or possible, depending on where the material is and how large a surface it covers. The THz method can transmit its energy beam through air or vacuum.

Patents

A patent application has been filed on this technology and follow-on patent applications are anticipated.

Licensing and Partnering Opportunities

NASA invites companies to discuss licensing or partnership opportunities involving this innovative measurement technology for commercial applications.

For More Information

For more information about this and other technology licensing opportunities, please visit:

Technology Transfer and Partnership Office
NASA Glenn Research Center
E-mail: ttp@grc.nasa.gov
Phone: 216-433-3484
<http://technology.grc.nasa.gov/>